

APPENDIX C – CONSTRUCTION SPECIFICATIONS

SECTION 02225

EXCAVATING, BACKFILLING, AND COMPACTING FOR SEWERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Excavating of trenches.
- B. Bedding of pipe.
- C. Backfilling trenches.
- D. Installing Identification Tape.

PART 2 - PRODUCTS

2.01 BEDDING AND BACKFILLING STONE

- A. Crushed Stone material shall conform to the Kentucky Transportation Cabinet's Standard Specifications for Road and Bridge Construction, Current Edition, latest revision.
- B. Bedding Stone: No. 9 Crushed Stone.
- C. Backfill Stone: No. 9 Crushed Stone.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Trenching may be accomplished by means of a backhoe, trenching machine or by hand depending on the construction area. At the Contractor's option, trenching by a trenching machine or by backhoe is acceptable except as noted below:
 - 1. Where the pipe line parallels a state highway and is being installed within the limits of the shoulder, a trenching machine must be used whenever practicable.
 - 2. Where the pipe line is being constructed close to other utilities, structures, building, or large trees, and it is reasonable to anticipate possible damage from the use of a backhoe, then trenching shall be made by hand methods.
- B. Clearing - All trees, stumps, bushes, shrubbery, and abandoned concrete or masonry structures within the limits of the trench shall be removed by the Contractor and disposed of in a manner satisfactory to the land owner and in accordance with federal, state, and local regulations. All clearing work shall be considered as incidental to the cost of laying pipe.
- C. Bracing and Sheet piling - In areas of unstable soils, bracing and sheet piling shall be provided to adequately protect the workers during pipe line installation.
 - 1. All requirements of the Occupational Safety and Health Act (OSHA) shall be met during trenching and backfill operations.

2. When sheeting and bracing are required, the trench width shall not be less than specified herein. As backfill is placed, the sheeting shall be withdrawn in increments not exceeding one (1) foot and the void left by the withdrawn sheeting shall be filled and compacted.
 3. The Engineer will not be responsible for determining requirements for bracing or sheeting.
- D. Excavated materials shall be piled in a manner that will not endanger the Work and will avoid obstructing driveways and sidewalks. Gutters shall be kept clear or other satisfactory provisions made for street drainage.

3.02 TRENCHING

A. General:

1. The Contractor shall perform all excavation of every description and of whatever substances encountered, including clearing over the pipe line route. All excavations for the pipe line shall be open-cut except at paved city and county roads, state and federal highways, railroads and blacktop or concrete driveways which shall be bored unless otherwise approved by Engineer. Banks of excavations shall be kept as nearly vertical as possible.
2. Trench widths at the top of the pipe shall not be less than or greater than that given in the following table:

| ALLOWABLE TRENCH WIDTHS | | |
|-----------------------------------|-----------------------------------|-----------------------------------|
| Pipe Diameter (inches) | Minimum Width (inches) | Maximum Width (inches) |
| 4 & less | 16 | 28 |
| 6 | 18 | 30 |
| 8 | 20 | 32 |
| 10 | 22 | 34 |
| 12 | 24 | 36 |
| 14 | 26 | 38 |
| 16 | 28 | 40 |
| 18 | 30 | 42 |
| 20 | 32 | 44 |

B. Trench Depth:

1. The trench shall be excavated to a depth sufficient to provide 48 inches of cover over the pipe. In addition, excavation shall be carried to a minimum of six (6) inches below pipe grade in rock.

- C. Blasting for excavation will be permitted only when proper precautions are taken for the protection of persons and property. Any damage caused by the blasting shall be repaired by the Contractor at his expense. The Contractor's methods of blasting and procedure shall conform to federal, state, and local laws and municipal ordinances. The Engineer will not be responsible, nor direct in any way, blasting practices of the Contractor.

3.03 FORCE MAIN BEDDING

- A. Refer to LFUCG Standard Drawings.
- B. The trench shall be excavated to a depth to allow a minimum of 48 inches cover over the top of the pipe.
- C. When the subgrade is found to be unstable or to include ashes, cinders, refuse, organic material, or other unsuitable material, such material shall be removed to the depth ordered by the Engineer and replaced under the directions of the Engineer with clean, stable backfill material. When the bottom of the trench or the subgrade is found to consist of material that is unstable to such a degree that, in the judgment of the Engineer it cannot be removed, a foundation for the pipe and/or appurtenance shall be constructed using piling, concrete, or other materials at the direction of the Engineer.

3.04 FORCE MAIN BACKFILLING

- A. Refer to LFUCG Standard Drawings

3.05 GRAVITY SEWER PIPE BEDDING

- A. Refer to LFUCG Standard Drawings.
- B. When the subgrade is found to be unstable or to include ashes, cinders, refuse, organic material, or other unsuitable material, such material shall be removed to the depth ordered by the Engineer and replaced under the directions of the Engineer with clean, stable backfill material. When the bottom of the trench or the subgrade is found to consist of material that is unstable to such a degree that, in the judgement of the Engineer it cannot be removed, a foundation for the pipe and/or appurtenance shall be constructed using piling, concrete, or other materials at the direction of the Engineer.

3.06 GRAVITY SEWER PIPE BACKFILLING

- A. Refer to LFUCG Standard Drawings.
 - 1. Final backfill beneath existing driveways, and beneath existing and proposed roads, shall be No. 9 Crushed Stone up to the subgrade of vehicular traffic surface courses. This does not apply to driveways in subdivisions under construction, because the location of driveways is unknown at the time the sewer is constructed.

3.07 INSTALLING IDENTIFICATION TAPE

- A. Detectable underground marking tape shall be installed over all utility lines. Care shall be taken to insure that the buried marking tape is not broken when installed and shall be Lineguard brand encased aluminum foil, Type III. The identification tape is manufactured by Lineguard, Inc., P.O. Box 426, Wheaton, IL 60187.
- B. The identification tape shall bear the printed identification of the plastic utility line below it, such as "Caution - Buried Below." Tape shall be reverse printed; surface printing will not be acceptable. The tape shall be visible in all types and colors of soil and provide maximum color contrast to the soil. The tape shall meet the APWA color code, and shall be two (2) inches in width. Colors are green for sewer and brown for force main.

- END OF SECTION -

SECTION 02608

MANHOLES

PART 1 - GENERAL

1.01 SUMMARY

The Contractor shall furnish all labor, material, and equipment necessary to construct manholes for sanitary and/or storm sewers, including steps, frames, and covers, together with all appurtenances as shown and detailed on the Drawings and specified herein. Manhole materials shall be precast concrete.

1.02 DEFINITIONS

- A. Standard Manhole: A standard manhole is defined as any manhole that is greater than 5 feet in depth, as measured from the invert of the manhole base at its center to the top (rim) of the manhole cover.
- B. Shallow Manhole: A shallow manhole is defined as any manhole that is 5 feet or less in depth, as measured in the preceding sentence.

PART 2 - PRODUCTS

2.01 CONCRETE MANHOLES - GENERAL

- A. Manholes shall conform in shape, size, dimensions, materials, and other respects as shown on the Drawings or specified herein.
- B. All concrete manholes shall have precast reinforced concrete developed bases. No other type of base will be allowed. Invert channels shall be factory constructed when the base is made. Sloping invert channels shall be constructed whenever the difference between the inlet and outlet elevation is 2 feet or less.
- C. The concrete manhole walls (barrels and cones) shall be precast concrete sections. The top of the cone shall be built of reinforced concrete adjustment rings to permit adjustment of the frame to meet the finished surface. Minimum strength of the concrete for the precast sections shall be 4,000 psi at the time of shipment.
- D. For concrete manholes, the inverts of the developed bases shall conform accurately to the size of the adjoining pipes. Side inverts shall be curved and main inverts (where direction changes) shall be laid out in smooth curves of the longest possible radius which is tangent, within the manhole, to the centerlines of adjoining pipelines.
- E. For concrete manholes, the cast iron frames and covers shall be the standard frame and cover as indicated on the Drawings and specified herein.
- F. Manholes shall be manufactured by Kentucky Precast, or approved equal.

2.02 PRECAST CONCRETE SECTIONS

- A. Precast concrete sections and appurtenances shall conform to the ASTM Standard Specifications for Precast Reinforced Concrete Manhole Sections, Designation C478, latest revision, with the following exceptions and additional requirements.

- B. The base section shall be monolithic for 4-foot diameter manholes. Manholes with diameter of 5 feet or larger shall have base slab.
- C. The wall sections shall be not less than 5 inches thick.
- D. Type II cement shall be used except as otherwise permitted.

2.03 CONCRETE MANHOLE - FRAMES AND COVERS

- A. The Contractor shall furnish all cast iron manhole frames and covers conforming to the Drawings or as specified herein.
- B. The castings shall be of good quality, strong, tough, evengrained cast iron, smooth, free from scale, lumps, blisters, sandholes, and defects of every nature which would render them unfit for the service for which they are intended. Contact surfaces of covers and frame seats shall be machined to prevent rocking of covers.
- C. All casting shall be thoroughly cleaned and subject to a careful hammer inspection.
- D. Castings shall be at least Class 25 conforming to the ASTM Standard Specifications for Gray Iron Casting, Designation A48, latest revision.
- E. Unless otherwise specified, manhole covers shall be 22-3/4 inches in diameter, weighing not less than 350 pounds per frame and cover. Manhole covers shall set neatly in the rings, with contact edges machined for even bearings and tops flush with ring edge. They shall have sufficient corrugations to prevent slipperiness. The covers shall have two (2) pick holes about 1-1/4 inches wide and 1/2 inch deep with 3/8-inch undercut all around. Covers shall not be perforated. Frames and covers shall be J.R. Hoe and Sons, Mc-350, or approved equal.
- F. All covers shall be marked in large letters "SANITARY SEWER".

2.04 MANHOLE STEPS (CONCRETE MANHOLES)

Manholes steps shall be the polypropylene plastic type reinforced with a 1/2 inch diameter deformed steel rod. The step shall be 10-3/4 inches wide and extend 5-3/4 inches from the manhole wall. Steps shall line up over the downstream invert of the manhole. The steps shall be embedded into the manhole wall a minimum of 3-3/8 inches. Steps shall be uniformly spaced at 12-inch to 16-inch intervals.

2.05 PREMOLDED ELASTOMERIC-SEALED JOINTS

All holes for pipe connections in concrete barrels and bases shall have a factory-installed flexible rubber gasket to prevent infiltration. The manhole boots shall conform to the latest revision of ASTM-C923. The boots shall be Contour Seal or Kor-N-Seal manufactured by National Pollution Control Systems, Inc., Nashua, NH; A-Lok Manhole Pipe Seal manufactured by A-Lok Corporation, Trenton, NJ; or an approved equal.

2.06 POLYETHYLENE DIAPHRAGM

- A. Polyethylene diaphragm manhole inserts shall be manufactured from corrosion-proof material suitable for atmospheres containing hydrogen sulfide and diluted sulfuric acid. Diaphragm shall be installed in manholes susceptible to inflow as indicated on the Drawings.

- B. The body of the manhole insert shall be made of high density polyethylene copolymer material meeting ASTM Specification D 1248, Class A, Category 5, Type III (the insert shall have a minimum impact brittleness temperature of -180 degrees Fahrenheit). The thickness shall be uniform 1/8 inch or greater. The manhole insert shall be manufactured to dimensions as shown on the Drawings to allow easy installation within the manhole frame.
- C. Gaskets shall be made of closed cell neoprene. The gasket shall have a pressure sensitive adhesive on one side and shall be placed under the weight bearing surface of the insert by the manufacturer. The adhesive shall be compatible with the manhole insert material so as to form a long lasting bond in either wet or dry conditions.
- D. Lift strap shall be attached to the rising edge of the bowl insert. The lift strap shall be made of 1 inch wide woven polypropylene web and shall be seared on all cut ends to prevent unraveling. The lift strap shall be attached to the manhole insert by means of a stainless steel rivet. Location of the lift strap shall provide easy visual location.
- E. Standard ventilation shall be by means of a valve or vent hole. Vent holes shall be on the side wall of the manhole insert approximately 3/4 inch below the lip. The valve or vent hole will allow a maximum release of 10 gallons per 24 hours when the insert is full.
- F. The manhole insert shall be manufactured to fit the manhole frame rim upon which the manhole cover rests. The Contractor is responsible for obtaining specific measurements of each manhole cover to insure a proper fit. The manhole frame shall be cleaned of all dirt, scale and debris before placing the manhole insert on the rim.

2.07 CLEANOUTS

Cleanouts shall be cast iron and extend to the finish grade and capped with a clean-out plug in accordance with details and at locations shown on the Drawings. Pipe shall be the same size as the gravity sewer line in which the cleanout is located. A 4-inch thick concrete pad, with 6" x 6", 1.9 x 1.9 wire mesh, 24 inches square, with the valve box lid section, shall be provided around each cleanout.

2.08 DROP CONNECTIONS

Drop connections shall be installed in the manhole as shown on the Drawings. The pipe material inside the drop manhole shall be of the same material as the sanitary sewer line. Any deviation from the standard drawing shall be approved by the Division of Engineering and the Division of Water Quality.

PART 3 - EXECUTION

3.01 FABRICATION - PRECAST SECTIONS

- A. Manhole sections shall contain manhole steps accurately positioned and embedded in the concrete when the section is cast.
- B. Sections shall be cured in an enclosed curing area and shall attain a strength of 4,000 psi prior to shipment.
- C. Knuckle hooks are preferred.
- D. Flat slab tops shall have a minimum thickness of 6 inches and reinforcement in accordance with ASTM C478.

- E. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the precast sections.
- F. Acceptance of the sections will be on the basis of material tests and inspection of the completed product and test cylinders if requested by the Engineer.
- G. Cones shall be precast sections of similar construction.

3.02 SETTING PRECAST MANHOLE SECTIONS

- A. Refer to Standard Drawings.
- B. Precast-reinforced concrete manhole sections shall be set so as to be vertical and with sections and steps in true alignment.
- C. All holes in sections used for their handling shall be thoroughly plugged with rubber plugs made specifically for this purpose.

3.03 ADJUSTING MANHOLE FRAMES AND COVERS TO GRADE

- A. Except where shown on the Drawings, the top of the precast concrete eccentric cone of a standard manhole or the top of the flat slab of a shallow manhole shall terminate 4 inches below existing grade in an unpaved non-traffic area except in a residential yard and 13 inches below existing grade in a paved or unpaved traffic area and in a residential yard. The remainder of the manhole shall be adjusted to the required grade as described hereinafter in paragraphs B and C of this article.
- B. When a manhole is located in an unpaved non-traffic area other than in a residential yard, the frame and cover shall be adjusted to an elevation 3 inches to 5 inches above the existing grade at the center of the cover. If field changes have resulted in the installed manhole invert elevation to be lower than the invert elevation shown on the Drawings, the adjustment to an elevation of 3 inches to 5 inches above existing grade shall be accomplished by the use of precast concrete adjusting rings. If field changes have resulted in the completed manhole invert to be greater than the invert shown on the Drawings and the cover higher than 5 inches above existing grade, then the top of the eccentric cone, when used, or the top of the barrel section, when used, shall be trimmed down so that the manhole cover, after installation, is no greater than 5 inches above existing grade at the center of the cover. The area around the adjusted frame and cover shall be filled with the required material, sloping it away from the cover at a grade of 1 inch per foot.
- C. When a manhole is located in a bituminous, concrete, or crushed stone traffic area, or in a residential yard, the frame and cover shall be adjusted to the grade of the surrounding area by the use of precast concrete adjusting rings. The adjusted cover shall conform to the elevation and slope of the surrounding area. If field changes have resulted in the installed manhole invert elevation to be so much higher than the invert elevation shown on the Drawings that the top of the eccentric cone, when used, or the top of the flat slab, when used, is less than the thickness of the frame and cover 7 inches from the grade of the surrounding area, then the top of the cone or barrel section shall be trimmed down enough to permit the cover, after installation, to conform to the elevation and slope of the surrounding area. After installation, the inside and outside surfaces shall receive a waterproofing bitumastic coating.
 - 1. The Contractor shall coordinate elevations of manhole covers in paved streets with the LFUCG. If resurfacing of the street in which sewers are laid is expected within

twelve (12) months, covers shall be set 1-1/2 inches above the existing pavement surface in anticipation of the resurfacing operations.

3.04 ADJUSTING SECTIONS

Only clean adjusting sections shall be used. Each adjusting section shall be laid in a bead of butyl mastic sealant and shall be thoroughly bonded.

3.05 SETTING MANHOLE FRAMES AND COVERS

- A. Manhole frames shall be set with the tops conforming to the required elevations set forth hereinbefore. Frames shall be set concentric with the top of the concrete and in a full bead of butyl mastic sealant so that the space between the top of the masonry and the bottom flange of the frame shall be completely watertight.
- B. Manhole covers shall be left in place in the frames on completion of other work at the manholes.

3.06 VACUUM TESTING (ASTM C1244)

A. Scope

- 1. This test method covers procedures for testing precast concrete manhole sections when using the vacuum test method to demonstrate the integrity of the installed materials and the construction procedures. This test method is used for testing concrete manhole sections utilizing mortar or mastic joints.
- 2. This test method is intended to be used as a preliminary test to enable the installer to demonstrate the condition of the concrete manholes prior to backfill. It may also be used to test manholes after backfilling; however, testing should be correlated with the connector supplier.
- 3. This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.
- 4. This test method is the companion to metric Test Method C 1244M; therefore, no SI equivalents are shown in this test method.

B. References, ASTM Standards:

- 1. C 822 Terminology Relating to Concrete Pipe and Related Products.
- 2. C 924 Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method.
- 3. C 969 Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.

C. Terminology

For definitions of terms relating to manholes, see Terminology C 822.

D. Summary of Practice

All lift holes and any pipes entering the manhole are to be plugged. A vacuum will be drawn and the vacuum drop over a specified time period is used to determine the acceptability of the manhole.

E. Significance and Use

This is not a routine test. The values recorded are applicable only to the manhole being tested and at the time of testing.

F. Preparation of the Manhole

1. All lift holes shall be plugged.
2. All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole.

G. Procedure

1. The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations.
2. A vacuum of 10 inches of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop to 9 inches of mercury.
3. The manhole shall pass if the time for the vacuum reading to drop from 10 inches of mercury to 9 inches of mercury meets or exceeds the values indicated in the table below.
4. Vacuum test time shall be a minimum of one minute.

| Minimum Test Times for Various Manhole Diameters (seconds) | | | | | | | | | |
|---|-------------------|----|----|----|----|----|----|-----|-----|
| Depth (ft) | Diameter (inches) | | | | | | | | |
| | 30 | 33 | 36 | 42 | 48 | 54 | 60 | 66 | 72 |
| 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 4 | 4 |
| 2 | 3 | 3 | 4 | 4 | 5 | 6 | 7 | 7 | 8 |
| 3 | 4 | 5 | 5 | 6 | 7 | 9 | 10 | 11 | 12 |
| 4 | 6 | 6 | 7 | 9 | 10 | 12 | 13 | 15 | 16 |
| 5 | 7 | 8 | 9 | 11 | 12 | 14 | 16 | 18 | 20 |
| 6 | 8 | 10 | 11 | 13 | 15 | 17 | 20 | 22 | 24 |
| 7 | 10 | 11 | 12 | 15 | 17 | 20 | 23 | 26 | 28 |
| 8 | 11 | 12 | 14 | 17 | 20 | 23 | 26 | 29 | 33 |
| 10 | 14 | 15 | 18 | 21 | 25 | 29 | 33 | 36 | 41 |
| 12 | 17 | 18 | 21 | 25 | 30 | 35 | 39 | 43 | 49 |
| 14 | 20 | 21 | 25 | 30 | 35 | 41 | 46 | 51 | 57 |
| 16 | 22 | 24 | 28 | 34 | 40 | 46 | 52 | 58 | 67 |
| 18 | 25 | 27 | 32 | 38 | 45 | 52 | 59 | 65 | 73 |
| 20 | 28 | 30 | 35 | 42 | 50 | 58 | 65 | 72 | 81 |
| 22 | 31 | 33 | 39 | 46 | 55 | 64 | 72 | 79 | 89 |
| 24 | 33 | 36 | 42 | 51 | 59 | 69 | 78 | 87 | 97 |
| 26 | 36 | 39 | 46 | 55 | 64 | 75 | 85 | 94 | 105 |
| 28 | 39 | 42 | 49 | 59 | 69 | 81 | 91 | 101 | 113 |
| 30 | 42 | 45 | 53 | 63 | 74 | 87 | 98 | 108 | 121 |

4. If the manhole fails the initial test, necessary repairs shall be made by an approved method. The manhole shall then be retested until a satisfactory test is obtained.
5. Use or failure of this vacuum test shall not preclude acceptance by appropriate water infiltration or exfiltration testing, (see Practice C 969), or other means.

H. Precision and Bias

No justifiable statement can be made either on the precision or bias of this procedure, since the test result merely states whether there is conformance to the criteria for the success specified.

- END OF SECTION -

SECTION 02732

SEWAGE COLLECTION LINES

PART 1 - GENERAL

1.01 SUMMARY

The Contractor shall furnish all labor, material, and equipment necessary to install gravity sewer piping together with all appurtenances as shown and detailed on the Drawings and specified herein.

PART 2 – PRODUCTS

2.01 PIPE AND FITTINGS

- A. Ductile Iron (DI) Pipe:
- B. Scope: This article covers the design and manufacture of ductile iron centrifugally cast on metal molds and ductile iron fittings.

Specific Requirements: Ductile iron pipe shall be furnished cement lined unless otherwise noted on the drawings or in other sections of these specifications. Ductile iron pipe shall be furnished with rubber gasket push-on joints except as may otherwise be noted on the drawings or in difficult working areas and with approval of the Engineer.

- 1. Pressure class shall be 250 psi for pipe sizes 20 inches or smaller and pressure class 200 psi for pipe sizes larger than 20 inches for mechanical and push-on joint pipe.
- 2. Thickness design of ductile iron shall conform in all aspects to the requirements of ANSI/AWWA C150/A 21.50 latest revision.
- 3. Manufacture and testing of ductile iron pipe shall conform in all aspects to the requirements of ANSI/AWWA C151/A 21.51 latest revisions .
- 4. Pipe Coatings
 - a. Interior Lining

(1) Condition of Ductile Iron Prior to Surface Preparation

All ductile pipe and fittings shall be delivered to the application facility without asphalt, cement lining, or any other lining on the interior surface. Because removal of old linings may not be possible, the intent of this specification is that the entire interior of the ductile iron pipe and fittings shall not have been lined with any substance prior to the application of the specified lining material and no coating shall have been applied to the first six (6) inches of the exterior of the spigot ends.

(2) Lining Material

The standard of quality is Protecto 401 Ceramic Epoxy. The material shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Any request for substitution must be accompanied by a successful history of lining pipe and fittings for sewer service, a test report verifying the following properties, and a certification of the test results.

- (a) A permeability rating of 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.
- (b) The following test must be run on coupons from factory lined ductile iron pipe:
 - (b1) ASTM B-117 Salt Spray (scribed panel) – Results to equal 0.0 undercutting after two years.
 - (b2) ASTM G-95 Cathodic Disbondment 1.5 volts @ 77°F. Results to equal no more than 0.5mm undercutting after 30 days.
 - (b3) Immersion Testing rated using ASTM D-714-87.
 - 20% Sulfuric Acid – No effect after two years.
 - 25% Sodium Hydroxide – No effect after two years.
 - 160°F Distilled Water – No effect after two years.
 - 120°F Tap Water (scribed panel) – 0.0 undercutting after two years with no effect.
- (c) An abrasion resistance of no more than 4 mils (.10mm) loss after one million cycles – European Standard EN 598: 1994 section 7.8 Abrasion resistance.

(3) Application

- (a) Applicator

The lining shall be applied by a competent firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.

(b) Surface Preparation

Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, etc. Any areas where oil, grease, or any substance which can be removed by solvent is present, shall be solvent cleaned using the guidelines outlined in DIPRA-1 Solvent Cleaning. After the surface has been made free of grease, oil, or other substances, all areas to receive the protective compounds shall be abrasively blasted using compressed air nozzles with sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc., are removed from the surface. Only slight stains and tightly adhering annealing oxide may be left on the surface. Any area where rust reappears before lining must be reblasted.

(c) Lining

After the surface preparation and within eight (8) hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry film thickness of Protecto 401. No lining shall take place when the substrate or ambient temperature is below 40 degrees Fahrenheit. The surface also must be dry and dust free. If flange pipe or fittings are included in the project, the lining shall not be used on the face of the flange.

(d) Coating of Bell Sockets and Spigot Ends

Due to the tolerances involved, the gasket area and spigot end up to six (6) inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum Protecto Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.

(e) Number of Coats

The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining material manufacturer. **No material shall be used**

for lining which is not indefinitely recoatable with itself without roughening of the surface.

(f) Touch-Up and Repair

Protecto Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.

(4) Inspection and Certification

(a) Inspection

(a1) All ductile iron pipe and fitting linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC-PA-2 Film Thickness Rating.

(a2) The interior lining of all pipe barrels and fittings shall be tested for pinholes with a non-destructive 2,500-volt test. Any defects found shall be repaired prior to shipment.

(a3) Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.

(b) Certification

The pipe or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification, and that the material used was as specified.

(5) Handling

Protecto 401 lined pipe and fittings must be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc., shall be placed inside the pipe and fittings for lifting, positioning, or laying.

b. Exterior Coating

Bituminous outside coating shall be in accordance with ANSI/AWWA C151/A 21.51 for pipe and ANSI/AWWA C110/A 21.10 for fittings.

5. Fittings and gaskets for mechanical and push-on joint ductile and cast iron pipe shall conform to the latest revisions of ANSI/AWWA C110/A 21.10 for

mechanical and push-on joint fittings, ANSI/AWWA C111/A 21.11 for gaskets, and ANSI/AWWA C153/A 21.53 for mechanical and push-on joint compact fittings. Mechanical and push-on joint fittings shall have pressure class rating of 250 psi for sizes 20 inches and smaller and 200 psi for sizes larger than 20 inches.

6. All ductile and cast iron fittings shall be ductile iron grade 80-60-03 in accordance with ASTM A339-55.
7. Flanged ductile iron pipe shall conform to the latest revisions of ANSI/AWWA C115/A 21.15. Bolt pattern of flange shall be in accordance with ANSI/AWWA C115/A 21.15 (which is equivalent to ASME/ANSI B16.1, Class 125 flange bolt pattern). Pipe shall have pressure class 250 rating. Gaskets shall be synthetic rubber ring gaskets with a thickness of 1/8 inch. Nuts and bolts shall be in accordance with ASME/ANSI B18.2.1, ASME/ANSI B18.2.2, ASME/ANSI B1.1, and ASTM A307.
8. Flanged fittings shall conform to the latest revisions of ANSI/AWWA C110/A 21.10 or ANSI/AWWA C153/A 21.53 (compact fittings). Gaskets shall be in accordance with ANSI/AWWA C111/A 21.11. Fittings shall have pressure class rating of 250 psi. Bolt pattern of flange shall be in accordance with ANSI/AWWA C115/A 21.15 (which is equivalent to ASME/ANSI B16.1, class 125 flange bolt pattern).
9. Restrained joint pipe and fittings shall be a boltless system equal to "Field-Lok" restraining gaskets or "TRFLEX Joint" as manufactured by U.S. Pipe & Foundry Company. All pipe inside of casing pipe shall have restraining gaskets.
10. Ball and socket restrained joint pipe and fittings shall be a boltless system equal to USIFLEX manufactured by U.S. Pipe & Foundry Company or FLEX-LOK manufactured by American Pipe Company. Pipe shall have a working pressure rating of 250 psi and have a maximum joint deflection of 15°. Nominal laying lengths shall be in range of 18 feet 6 inches to 20 feet 6 inches.
11. Manufacturers

Pipe shall be as manufactured by U.S. Pipe & Foundry Company, Clow, American Cast Iron Pipe Company, or equal.
12. Marking

Pipe or fitting shall have the ANSI/AWWA standard, pressure (or thickness) class, diameter, DI or ductile noted, manufacturer, and country and year where cast on the outside of the body.
13. No separate pay item has been established for fittings and no determination of the number of fittings required on the job has been made. The Contractor, during the bidding phase, shall determine the number of fittings required on the job and include the cost of fittings and installation in the unit price for pipe.

C. Polyvinyl Chloride (PVC) Pipe

1. Solid Wall PVC Pipe (SDR 35)
 - a. PVC pipe and fittings less than 15 inches in diameter shall conform to the requirements of ASTM Standard Specifications for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings, Designation D 3034. Pipe and fittings shall have a minimum cell classification of 12454B or 12454C as defined in ASTM D-1784. All pipe shall have a pipe diameter to wall thickness ratio (SDR) of a maximum of 35.
 - b. PVC pipe and fitting with diameters 18-inch through 27-inch shall conform to the requirements of ASTM D-17845 and ASTM F-679. Pipe and fittings shall have a minimum cell classification of 14545C. The minimum wall thickness shall conform to T-1 as specified in ASTM F-679.
 - c. Joints shall be push-on bell and spigot type using elastomeric ring gaskets conforming to ASTM D 3212 and F 477. The gaskets shall be securely fixed into place in the bells so that they cannot be dislodged during joint assembly. The gaskets shall be of a composition and texture which is resistant to common ingredients of sewage and industrial wastes, including oils and groundwater, and which will endure permanently under the conditions of the proposed use.
 - d. Pipe shall be furnished in lengths of not more than 13 feet. The centerline of each pipe section shall not deviate from a straight line drawn between the centers of the openings at the ends by more than 1/16 inch per foot of length.
 - e. PVC pipe shall not have a filler content greater than ten percent (10%) by weight relative to PVC resin in the compound.
 - f. PVC pipe shall be clearly marked at intervals of 5 feet or less with the manufacturer's name or trademark, nominal pipe size, PVC cell classification, the legend "Type PSM SDR 35 PVC Sewer Pipe" and the designation "ASTM D 3034", or "ASTM F-679". Fittings shall be clearly marked with the manufacturer's name or trademark, nominal size, the material designation "PVC", "PSM" and the designation "ASTM D 3034", or "ASTM F-679".
 - g. PVC pipe shall have minimum pipe stiffness of 46 psi for each diameter when measured at 5 percent vertical ring deflection and tested in accordance with ASTM D 2412.
 - h. Five (5) copies of directions for handling and installing the pipe shall be furnished to the Contractor by the manufacturer at the first delivery of pipe to the job. PVC pipe installation shall conform to ASTM D-2321 latest revision.
 - i. Pipe shall be as manufactured by H & W Pipe Company, or equal.

D. Reinforced Concrete Pipe

1. All reinforced concrete pipe shall conform to the requirements of ASTM C76, latest edition. Class shall be as shown on the Drawings.
2. Joints shall be bell and spigot type using rubber Forsheda 138 or Forsheda 103 gaskets (or approved equal) and shall conform to ASTM C443.
3. The pipe shall be furnished in standard lengths of 8 feet to 16 feet.
4. The pipe shall be permanently marked showing the nominal inside diameter, manufacture date, ASTM C76 class, and manufacturer's name. These markings for 30-inch diameter and larger shall be inscribed on the pipe exterior and stenciled on the interior with paint or permanent ink.
5. There shall be no lift holes.
6. Pipe shall be as manufactured by Independent Concrete Pipe Company or approved equal.
7. Pipe Coatings

a. Interior Lining

(1) Description

All concrete pipe and fittings shall have a high build protective lining on the interior. All surface areas must be smooth without voids and projections, i.e. casting or manufacturing imperfections. Any patching of the interior of the concrete pipe shall be satisfactorily repaired by the pipe manufacturer by using a two component epoxy grout. No patching compounds containing a latex or acrylic base, or curing compounds shall be used on the interior surfaces of the concrete pipe to be lined. All rough and sharp edges on bells and spigots shall be rounded smooth with at least 1/8-inch radius.

(2) Lining Material

The material must be a high build multi-component amine cured novalac epoxy polymeric lining. The standard of quality is Inner-Liner by Vulcan Painters, Birmingham, Alabama. Equal products considered are Protecto Pipe Lining 1011 and PERMITE 9043 Type 2 polyamide epoxy. Any other alternates must be accompanied by the following:

- (a) The permeability rating equal to the specified material when tested according to Method A of ASTM E-96-66, Procedure A, with a test duration of 42 days as reported by an independent laboratory.

- (b) A statement from the Manufacturer of the submitted material attesting to the fact that at least 20% of the volume of the lining contains ceramic quartz pigment or similar inert material that will not be affected by the sewer liquids and gas.
 - (c) A laboratory report containing test data for immersion in acids, bases, and deionized water equal to the performance of the specified material using ASTM D-714-56 (1974) for the rating method.
 - (d) A statement concerning recoatability and repair to the lining.
- (3) Concrete Pipe and Manholes
- (a) Surface Preparation

All centrifugally cast concrete pipe shall have the interior fines, which include the gray layer of loosely-bound laitance, washed out at the time of manufacture. The intent is to expose tightly-bound concrete so that the lining will have a sound substrate for adhesion. After the pipe has cured the equivalent of seven (7) days at 77°F, the interior of the pipe exposed to liquids and gases shall be blasted and cleaned to remove all laitance, form oils, or other loose material. All none-water soluble grease or oils shall be removed by the pipe manufacturer before surface preparation by steam cleaning.

(b) Lining

After cleaning, the lining material shall be applied at 40 mils for the complete system using a centrifugal lance applicator. No lining shall take place over grease, oil, etc., that would be detrimental to the adhesion of the compound to the substrate. The compound shall not be applied when the substrate temperature is below 40°F or in adverse atmosphere conditions which will cause detrimental blistering, pinholing, or porosity of the film. In no case shall the lining be applied when the concrete surface is above 14% moisture content.

(c) Coating of Gasket and Spigot Ends

Due to tolerances, the joint areas must be coated with 6 mils, 10 mils maximum, Inner-Liner joint compound. It is the pipe manufacturer's responsibility to ensure that these tolerances are acceptable. This coating shall be hand-applied by brush to ensure a continuous protective

barrier. Care should be taken that the coating is smooth without excess buildup in the gasket area of the bell or on the gasket groove on the spigot end. All materials for the gasket groove and spigot end shall be applied after the application of the lining.

(4) Inspection and Certification

(a) Inspection

(a1) All concrete pipe and manholes shall be checked for thickness using a magnetic film thickness gauge on metal coupons attached to 5% of the pipe lined. **Note:** All dry film thickness shall be measured by application Specification No. 2 (SSPC-PA2 November 1, 1982).

(a2) The barrel of all pipe and fittings shall be pinhole-detected with a non-destructive 2,500-volt pinhole test. This test shall take place as soon as the lining is cured to prevent damage or contamination on the lining surfaces.

(a3) Each pipe joint and fitting shall be marked with the date of application of the lining system and with its numerical sequence of application on that date.

(a4) All pipe and fittings shall be inspected visually before and after installation, if possible, to ensure that any defect or damage to the pipe or lining is repaired prior to placing in service.

(b) Certification

The pipe or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification, and that the material used was as specified, and that the material was applied as required by the specification.

(5) Field Touch-Up

(a) Surface Preparation

(a1) The damaged or abraded area should be brushed vigorously with a wire brush or sanded with coarse sandpaper to remove all loose material. After the surface has been cleaned, care should be

taken to remove all dust from the cleaning operation. This can be accomplished by blowing-off with compressed air or by brushing with a dry brush.

(a2) Inner-Liner Joint Compound shall be used for touchup or repair and shall be mixed thoroughly in strict accordance with manufacturer's recommendations. After the material has been thoroughly mixed, apply to the prepared surface by either brush, roller, or airless spray. The material will be applied in one or two coats, as directed by the Engineer, depending on the size of the damaged area and whether it goes to the substrate or not. All touch-up shall be applied using the guidelines established for temperature and moisture content in paragraph for "Lining".

b. Exterior Coating

All reinforced concrete pipe shall be water-proofed on the exterior with asphalt coating. (Steel cylinder concrete pipe does not have to be water-proofed.)

PART 3 - EXECUTION

3.01 PIPE LAYING

- A. All pipe shall be laid with ends abutting and true to the lines and grades indicated on the Drawings. The pipe shall be laid straight between changes in alignment and at uniform grade between changes in grade. Pipe shall be fitted and matched so that when laid in the trench, it will provide a smooth and uniform invert. Supporting of pipe shall be as set out in Section 02225 and in no case shall the supporting of pipe on blocks be permitted.
- B. Before each piece of pipe is lowered into the trench, it shall be thoroughly swabbed out to insure its being clean. Any piece of pipe or fitting which is known to be defective shall not be laid or placed in the lines. If any defective pipe or fitting shall be discovered after the pipe is laid, it shall be removed and replaced with a satisfactory pipe or fitting without additional charge. In case a length of pipe is cut to fit in a line, it shall be so cut as to leave a smooth end at right angles to the longitudinal axis of the pipe and beveled to match the factory bevel for insertion into gasketed joints. Bevel can be made with hand or power tools.
- C. The interior of the pipe, as work progresses, shall be cleaned of dirt, jointing materials, and superfluous materials of every description. When laying of pipe is stopped for any reason, the exposed end of such pipe shall be closed with a plywood plug fitted into the pipe bell so as to exclude earth or other material and precautions taken to prevent flotation of pipe by runoff into trench.

- D. All pipe shall be laid starting at the lowest point and installed so that the spigot ends point in the direction of flow.

3.02 JOINTING

All joint surfaces shall be cleaned immediately before jointing the pipe. The bell or groove shall be lubricated in accordance with the manufacturer's recommendation. Each pipe unit shall then be carefully pushed into place without damage to pipe or gasket. All pipe shall be provided with home marks to insure proper gasket seating. Details of gasket installation and joint assembly shall follow the direction of the manufacturer's of the joint material and of the pipe. The resulting joints shall be watertight and flexible. **No solvent cement joints shall be allowed.**

3.03 UTILITY CROSSING CONCRETE ENCASEMENT

- A. At locations shown on the Drawings, required by the Specifications, or as directed by the Engineer, concrete encasement shall be used when the clearance between the proposed sanitary sewer pipe and any existing utility pipe is 18 inches or less. Utility pipe includes underground water, gas, telephone and electrical conduit, storm sewers, and any other pipe as determined by the Engineer.
- B. There are two cases of utility crossing encasement. Case I is applicable when the proposed sanitary sewer line is **below** the existing utility line. Case II is applicable when the proposed sanitary sewer line is laid **above** the utility line. In either case, the concrete shall extend to at least the spring line of each pipe involved.
- C. Concrete shall be Class B (3000 psi) and shall be mixed sufficiently wet to permit it to flow between the pipes to form a continuous bridge. In tamping the concrete, care shall be taken not to disturb the grade or line of either pipe or damage the joints.
- D. Concrete for the Work is not a separate pay item and will be considered incidental to utility pipe installation.

3.04 TESTING OF GRAVITY SEWER LINES

- A. After the gravity piping system has been brought to completion, and prior to final inspection, the Contractor shall rod out the entire system by pushing through each individual line in the system, from manhole to manhole, appropriate tools for the removal from the line of any and all dirt, debris, and trash. If necessary during the process of rodding the system, water shall be turned into the system in such quantities to carry off the dirt, debris, and trash.
- B. During the final inspection the Engineer will require all flexible sanitary sewer pipe to be mandrel deflection tested after installation.
 - 1. The mandrel (go/no-go) device shall be cylindrical in shape and constructed with nine (9) evenly spaced arms of prongs. The mandrel dimension shall be 95 percent of the flexible pipe's published ASTM average inside diameter. Allowances for pipe wall thickness tolerances of ovality (from shipment, heat, shipping loads, poor production, etc.) shall not be deducted from the ASTM average inside diameter, but shall be counted as part of the 5 percent allowance. The contact length of the

mandrel's arms shall equal or exceed the nominal diameter of the sewer to be inspected. Critical mandrel dimensions shall carry a tolerance ± 0.001 inch.

2. The mandrel inspection shall be conducted no earlier than 30 days after reaching final trench backfill grade provided, in the opinion of the Engineer, sufficient water densification or rainfall has occurred to thoroughly settle the soil throughout the entire trench depth. Short-term (tested 30 days after installation) deflection shall not exceed 5 percent of the pipe's average inside diameter. The mandrel shall be hand pulled by the contractor through all sewer lines. Any sections of the sewer not passing the mandrel test shall be uncovered and the Contractor shall replace and recompact the embedment backfill material to the satisfaction of the Engineer. These repaired sections shall be retested with the go/no-go mandrel until passing.
 3. The Engineer shall be responsible for approving the mandrel. Proving rings may be used to assist in this. Drawings of the mandrel with complete dimensioning shall be furnished by the Contractor to the Engineer for each diameter and type of flexible pipe.
- C. The pipe line shall be made as nearly watertight as practicable, and leakage tests and measurements shall be made. All apparatus and equipment required for testing shall be furnished by the Contractor and the cost shall be included in the unit price bid for pipe and manholes.
1. The Engineer may require the Contractor to smoke test the first section (manhole to manhole) of each size of pipe and type of joint prior to backfilling, to establish and check laying and jointing procedures. The test shall consist of smoke blown into closed-off sections of sewer under pressure and observing any smoke coming from the pipe line indicating the presence of leaks. Other supplementary smoke tests prior to backfilling may be performed by the Contractor at his option; however, any such tests shall not supplant the final tests of the completed work unless such final tests are waived by the Engineer.
 2. Where the groundwater level is more than 1 foot above the top of the pipe at its upper end, the Contractor shall conduct either infiltration tests or low pressure air tests on the completed pipeline.
 3. Where the groundwater level is less than 1 foot above the top of the pipe at its upper end, the Contractor shall conduct either exfiltration tests or low pressure air tests on the completed pipeline.
- D. Low-pressure air tests shall be performed on all gravity sanitary sewers to verify water-tightness of pipe joints and connections. The Contractor shall perform testing on each manhole-to-manhole section of sewer line after placement of backfill.

Testing of Polyvinyl Chloride (PVC) and Ductile Iron (DI) pipe sewer lines shall be performed in accordance with the current editions of ASTM F1417, "Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air," and UNI-B-6, "Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe," respectively. Testing of reinforced concrete pipe sewer lines shall be performed in accordance with the current edition of ASTM C 924, "Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method."

All testing equipment shall be inspected by the Engineer to ensure that equipment is functioning properly.

The rate of air loss in the section under test shall be determined by the time-pressure drop method. The time required in minutes for the pressure in the section under test to decrease from 3.5 to 2.5 psig shall be not less than that indicated in the referenced standards.

Immediately following the low-pressure air test, the Contractor shall notify the Engineer of the test results. A Low-Pressure Air Test Report shall be completed by the Contractor during testing. The report shall be completed according to the procedures outlined in LFUCG's Construction Inspection Manual, current edition. A copy of the completed Low-Pressure Air Test Report shall be provided to the Engineer and LFUCG-Division of Water Quality for each test.

Pipes failing the pressure test will not be accepted and shall be repaired or replaced until a successful test is achieved.

When conducting a low-pressure air test, the Contractor shall securely install and brace all plugs prior to pressurizing the pipe. Personnel shall not be permitted to enter manholes when the sewer pipe is pressurized.

- E. Infiltration tests (for concrete pipe only) shall be made after underdrains, if present, have been plugged and other groundwater drainage has been stopped such that the groundwater is permitted to return to its normal level insofar as practicable.
 - 1. Upon completion of a section of the pipeline, the line shall be dewatered and a satisfactory test conducted to measure infiltration for at least 24 hours. The amount of infiltration, including manholes, tees and connections, shall not exceed 200 gallons per nominal inch diameter per mile of sewer per 24 hours.
- F. Exfiltration tests (for concrete pipe only) which subject the pipeline to an internal pressure, shall be made by plugging the pipe at the lower end and then filling the line and manholes with clean water to a height of 2 feet above the top of the sewer at its upper end. Where conditions between manholes may result in test pressures which would cause leakage at the plugs or stoppers in branches, provisions shall be made by suitable ties, braces and wedges to secure the plugs against leakage resulting from the test pressure.
 - 1. The rate of leakage from the sewers shall be determined by measuring the amount of water required to maintain the level 2 feet above the top of the pipe.
 - 2. Leakage from the sewers under test shall not exceed the requirements for leakage into sewers as hereinbefore specified.
- G. The Contractor shall furnish suitable test plugs, water pumps, and appurtenances, and all labor required to properly conduct the tests. Suitable bulkheads shall be installed, as required, to permit the test of the sewer. The Contractor shall construct weirs or other means of measurements as may be necessary.

- H. Should the sections under test fail to meet the requirements, the Contractor shall do all work of locating and repairing the leaks and retesting as the Engineer may require without additional compensation.
- I. If in the judgment of the Engineer, it is impracticable to follow the foregoing procedures for any reason, modifications in the procedures shall be made as required and as acceptable to the Engineer, but in any event, the Contractor shall be responsible for the ultimate tightness of the line within the above test requirements.

- END OF SECTION -